## **ELEX CemCat**

# Clean Air is our Mission Multi Pollution Control with SCR Technology

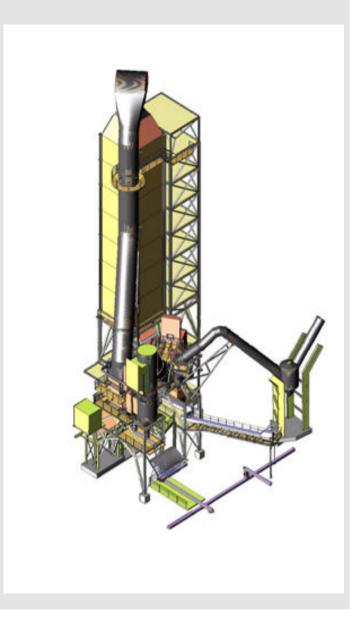






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#### Who We Are

- Elex CemCat AG A partnership between Polysius and Elex
- Elex Experience (1934)
  - SCR for Waste Incineration Plants, approx. 60
  - SCR for Cement, 2 of the 3 first systems worldwide
  - The 2 only systems (high-dust) operating in cement
- Polysius Experience (1859)
  - 150 Years of Cement Plant Equipment Design and Manufacturing
  - Pyroprocessing and Environmental Expertise around the World
  - World Class R&D Facilities, Pilot Plant Stations and Industrial Measuring Campaigns
- Polysius and Elex Partnership creates unique expertise for SCR in Cement Applications





## SCR – State of Technology in Cement

- Plants with SCR
  - Solnhofen, Germany, HD, started 2001, currently shut down
  - Cementeria di Monselice, Italy, HD, operating since 2006
  - Cementeria di Sarche , Italy, SD, operating since 2007, Lepol system
  - Schwenk Mergelstetten, Germany, HD, started 2010
- Projects
  - Rohrdorf Zement, Germany, TE, commissioning in 3/2011
  - Monselice, Italy, Italcementi, SD, tendering process, commissioning 3/2012
  - Mannersdorf, Austria, Lafarge, SD, tendering process, commissioning 1/2012
  - **–** ...
  - → SCR enforced by EU directive.
- NH<sub>3</sub> from raw materials not emitted but utilized
- Can be combined with other technologies like MSC and SNCR.





#### SCR in Cement vs. other Industries





- State of the art in waste incinerators, power plants and other industries.
  - In use for 30+ years in Japan and EU
  - Low emission thresholds in many countries
  - 95% NOx reduction possible
  - VOC, PCDD/F oxidation
  - Elemental mercury oxidation
- Technical situation is the same in cement production, except dust in flue gas
  - Content is higher
  - Stickiness is stronger
  - Abrasiveness is lower

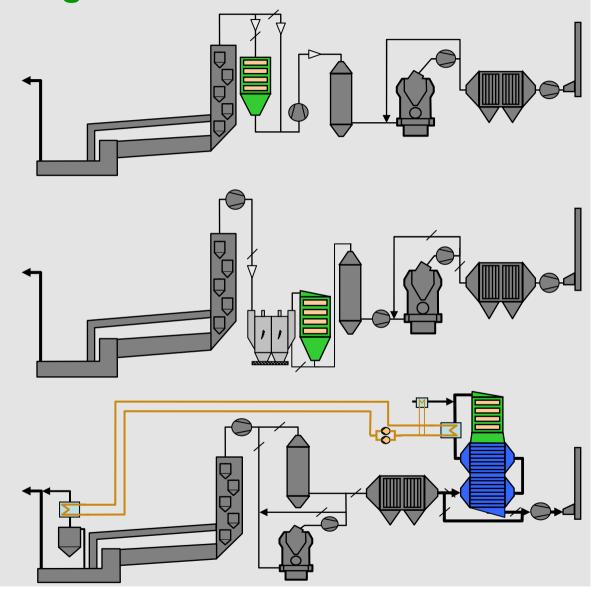


## Flow sheet configurations

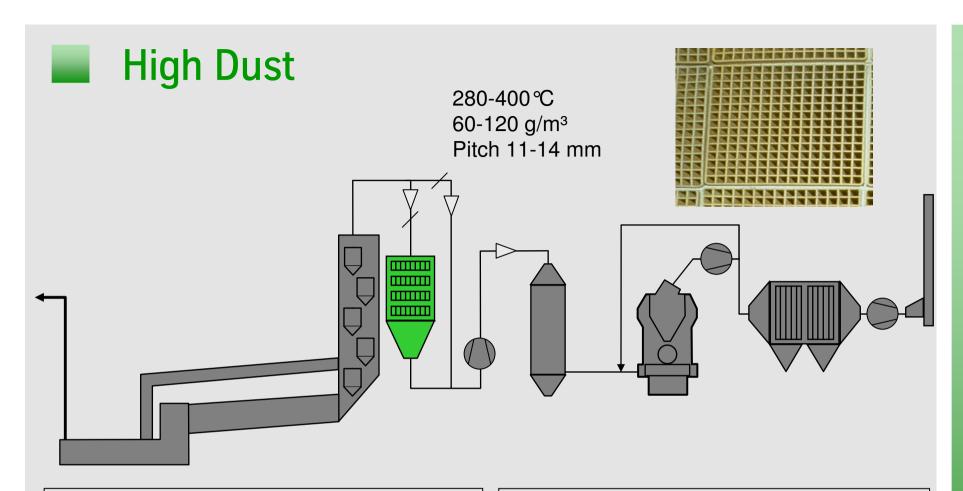
• High Dust (HD)

• Semi Dust (SD)

Tail End (TE)





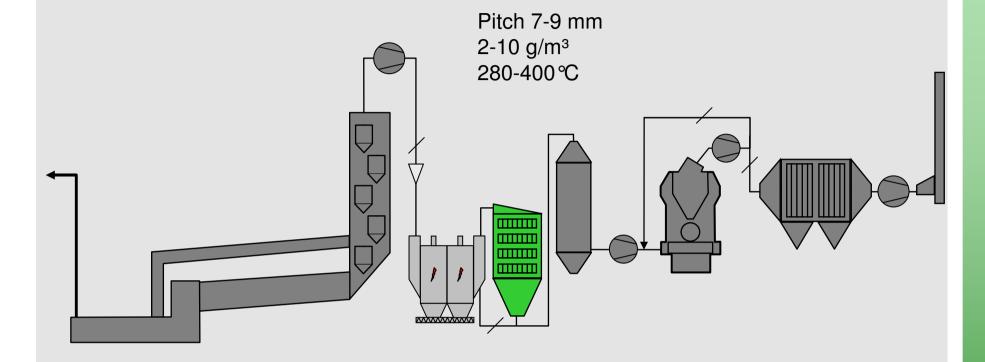


- Lowest investment cost
- + Lowest power consumption
- + Flue gas temperature suitable for SCR
- + No interference with main process
- + Easiest option for retrofits
- + High dust protects against poisoning

High amount of dust requires online cleaning

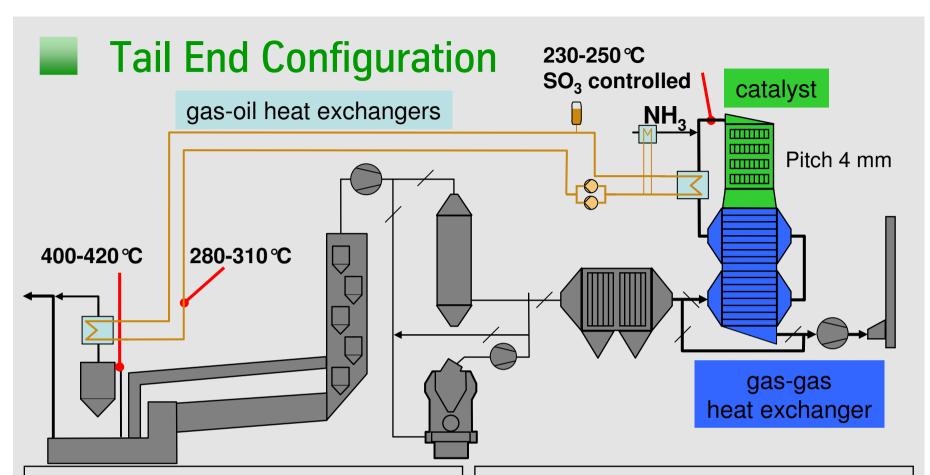


## Semi Dust



- + Low dust cleaning in catalyst
- + Easy bypass arrangement
- + No interference with main process
- Higher cost of installation
- Sometimes complex duct routings in retrofits





- + Very low dust concentrations
  - ⇒ No dust cleaning required
- + Longer lifetime of catalyst expected
- + Improved VOC und PCDD/F reduction due to small pitch
- + Easy erection

- High cost of installation
- Requires reheating of flue gas

  ⇒ No power generation at cooler possible
- Higher power consumption (fan)
- Mercury effected only with additional scrubber downstream
- SCR coupled to clinker cooler process
- Corrosion risk downstream of catalyst





## Monselice, Italy

#### SCR design data:

• Kiln output: 2640 stpd

• Gas flow: 160'000 Nm3/h

• Temperature: 300 – 320 °C

• Stat. pressure: -80 mbar

•  $NO_x$  in: 2260 mg/Nm<sup>3</sup>

•  $NO_x$  out: 232 mg/Nm<sup>3</sup> (@ 2.5%  $O_2$ )

•  $NO_X$  stack: 200 mg/Nm<sup>3</sup> (@ 4.5%  $O_2$ )

•  $NH_3$ -Slip: < 5 mg/Nm<sup>3</sup>

• NH<sub>4</sub>OH 25%: 445 kg/h

100 mg/Nm<sup>3</sup> approx. 0,3 lb/st







## Mergelstetten, Germany

#### SCR design data:

• Kiln output: 3300 stpd

• Gas flow: 220'000 Nm3/h

• Temperature: 370 – 400 °C

• Stat. pressure: -5 mbar

•  $NO_x$  in: 1500 mg/Nm<sup>3</sup>

•  $NO_X$  out: 100 mg/Nm<sup>3</sup> (@ 10%  $O_2$ )

•  $NH_3$ -Slip: < 5 mg/Nm<sup>3</sup>

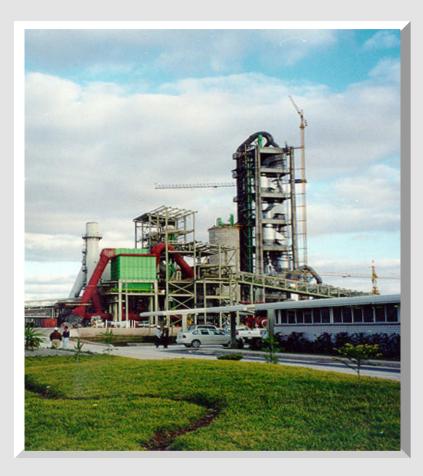
100 mg/Nm³ approx. 0,3 lb/st







### **Integration and Innovation**



#### Integration:

- To reduce pollutants without compromising the process
  - ⇒ high-dust or semi-dust
- To avoid adding equipment that generates its own high environmental impact
  - ⇒ high-dust
- To avoid cluttering the process with multiple systems each capable of only addressing a single pollutant

#### Innovation:

- To adjust the process to cement dust
  - ⇒ reliability
- To limit deactivation of catalyst
  - ⇒ reliability





### Reliability – Dust Cleaning is the Key

#### **Hard Coatings**



- Dust contains clay minerals and anhydride
- + No longer seen with our optimized cleaning design

#### Clogging



- High dust concentration and high stickiness
- + Reversible with our optimized cleaning design



Initial problems are solved.





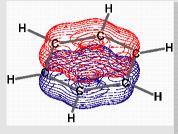
## Reliability – Life time of catalyst

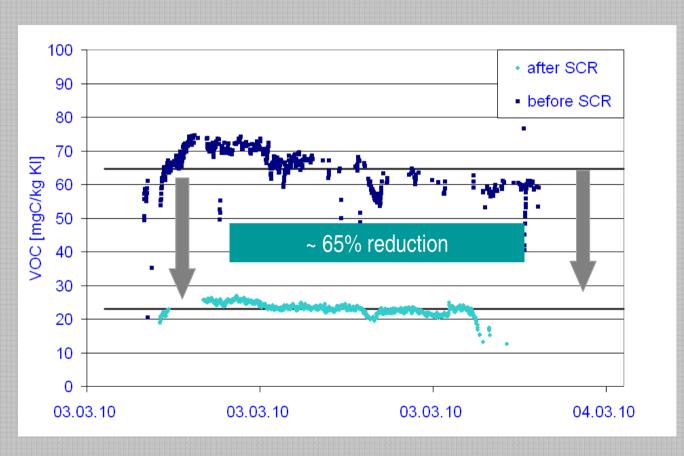
- Mechanical erosion
  - Lower than in power plants, dust is finer and less aggressive
  - ⇒ Not a significant effect on life time seen in Monselice
- Physical coating with anhydrite and clays
  - 7-25% activity loss in 7.500 h. This is covered with the design
  - Can be cleaned by washing
  - ⇒ Not an obstacle
- Poisoning with Thallium in Semi Dust
  - 43% activity loss after 16.000 h in combination with phosphorous
  - 48% activity loss after 1.650 h
  - Problems are reported from small pilot installations
  - Little dust seems to be critical
  - ⇒ Not yet fully understood





#### THC Oxidation – Performance Monselice SCR Unit

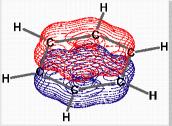


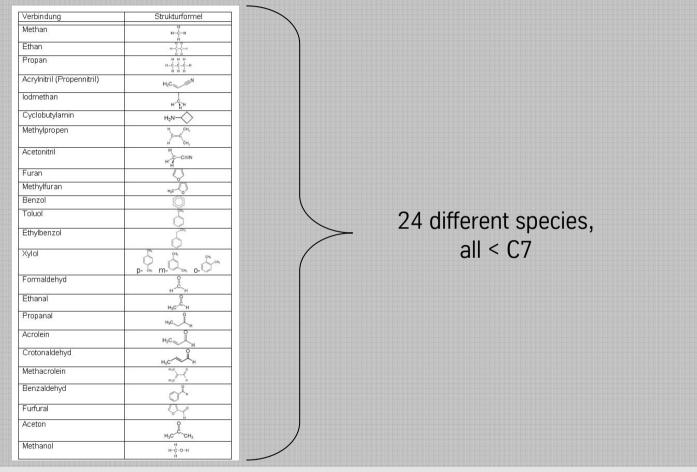






#### THC Oxidation – Performance Monselice SCR Unit

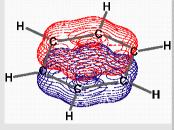


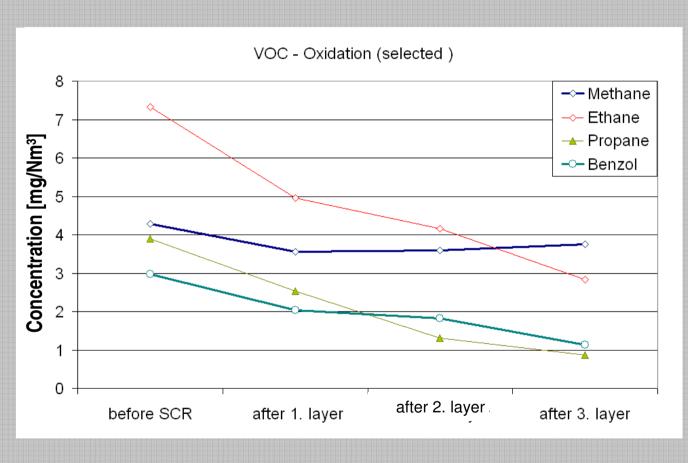






## THC Oxidation – Species Oxidized

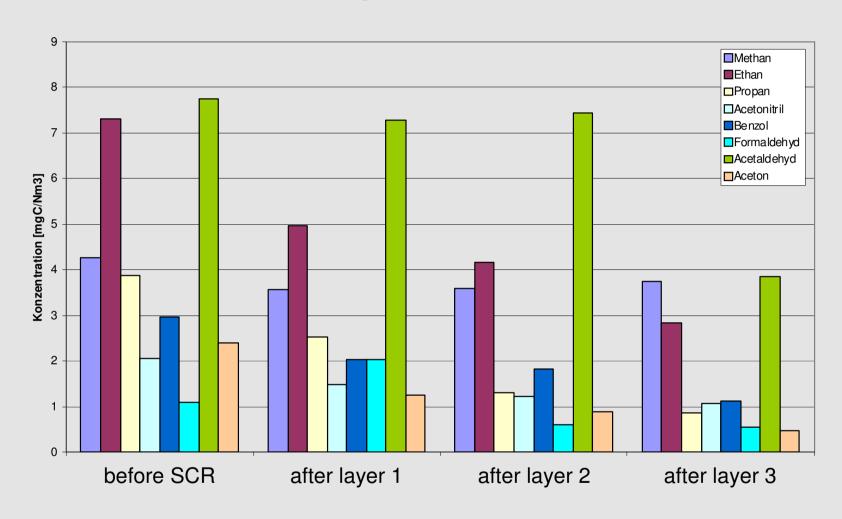








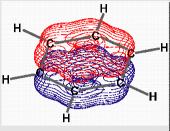
## VOC Oxidation – Species Oxidized

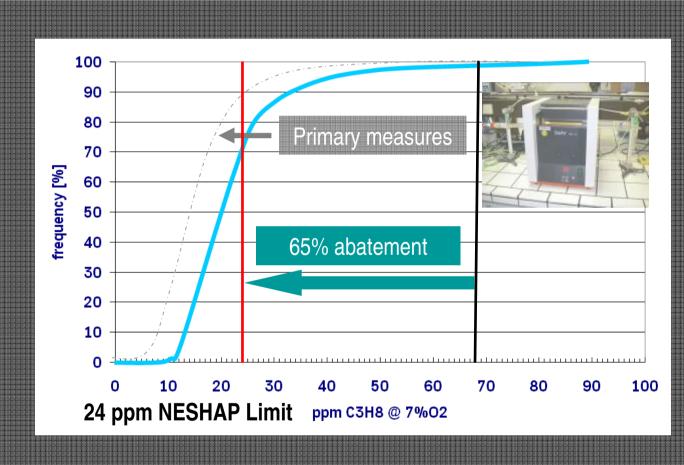






#### **VOC Oxidation – Frequency Distribution of VOC Emissions**



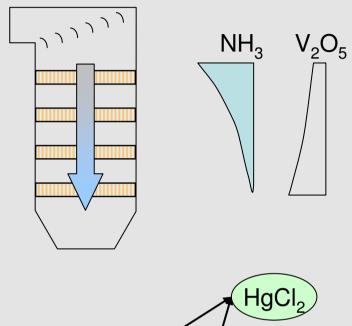


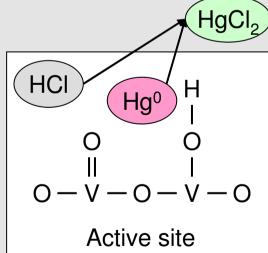
#### Sufficient for all plants!





## Mercury oxidation



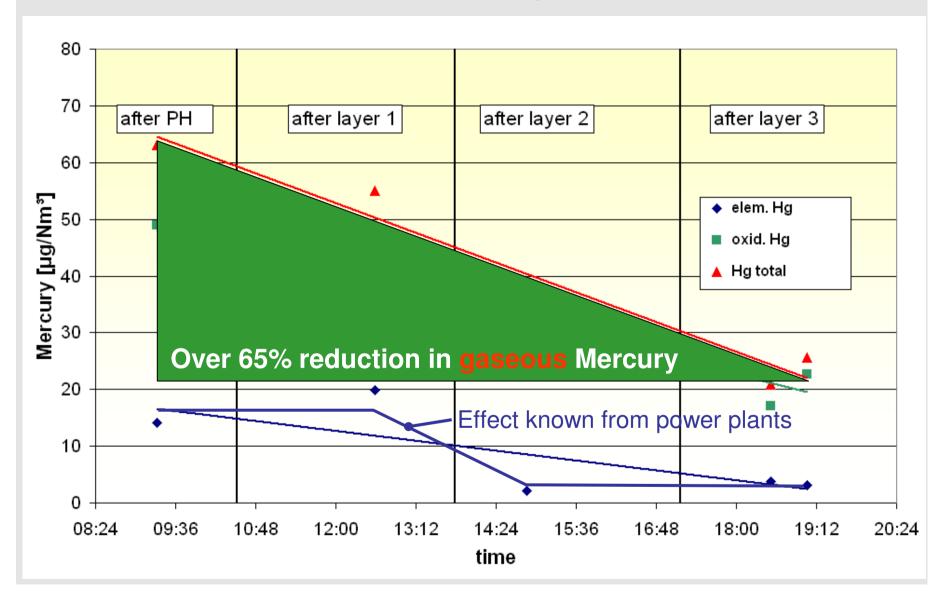


- Ammonia decreases through reactor
  - Surplus of active sites increases
- Surplus of active sites (V<sub>2</sub>O<sub>5</sub>) results in increasing rate of...
  - VOC oxidation
  - Dioxin and furan oxidation
  - SO<sub>2</sub> to SO<sub>3</sub> oxidation
  - Mercury oxidation
- ⇒ Competing reactions on catalyst
- ⇒ Sizing determines the rate of non-NO<sub>x</sub> conversion
- Reaction mechanism
  - Adsorption of halogens on V<sub>2</sub>O<sub>5</sub>
  - Adsorption of elemental Hg on V<sub>2</sub>O<sub>5</sub>
  - Desorption of HgCl<sub>2</sub> and H<sub>2</sub>O
  - Oxidation of  $V_2O_4$  to  $V_2O_5$





## Measurement of mercury in Monselice







## **Conclusions of Mercury Measurement**

- Significant reduction of gaseous mercury
  - Using the standard CemCat SCR
  - Without compromising SCR's ability to remove other pollutants
  - Additional measuring campaigns are planned
    - Current data is from a single installation
- Mercury extraction with CKD, ACI or scrubbers benefits from SCR
- Potential in US
  - Applying data from the European study shows potentially around 70% of existing US plants would be in compliance with the stringent new NESHAP regulations
- Further research will help improve these results



## -

## Summary

- SCR has proven itself in significantly reducing  $NO_X$ , VOC and Dioxins and Furans in the Cement Industry
- Preliminary data shows a significant reduction of Mercury emissions by a recent measuring campaign in Europe
- Reliable dust cleaning in High-Dust configuration
- Eliminates need to invest in a separate pollution control technology for each of the targeted pollutants
- SCR has already established itself as a viable technology for multi-component emission reduction in the power and incinerator industries
  - Polysius/CemCat is poised to aggressively test SCR technology with cement industry and regulatory partners in the U.S.

